THE BUILT-IN SHUTTER

The escapements you have studied so far are cleverly designed to fit into the cramped quarters around the lens. A complex problem in the design of any shutter is proper use of available space. And in most of the shutters examined in previous lessons, the shutter mechanism fits into a housing which also serves as the lens mount.

The ingenuity of the designers has produced escapement gear trains and other parts that are curved to follow the shape of the housing. Even the main lever -- in larger models of the Compur, for example -- may be a ring which fits around the lens barrel to take best advantage of the existing space. Main levers in many other shutters follow this circular pattern, and usually provide for complete shutter operation with a very minimum amount of movement.

So the parts in the modular shutters you've studied must be small in order to fit the available space. Small parts require high precision -- and the shutter accuracy is frequently the result of fine craftsmanship as well as good design.

> NOTE: Shutters such as the Synchro-Compur 00-MXV and the Prontor SVS are examples of modular shutters -- that is, shutters made by a single manufacturer which may be used on cameras of many different makes.

In contrast to the modular shutter, the BUILT-IN SHUTTER is integral with the camera itself -- and, as such, is unique to the particular camera in which it is used. Built-in shutters may be extremely simple -- such as you studied in the Kodak Instamatic and Brownie Reflex cameras. Or, they may be quite complex -- such as the focal-plane shutters you will examine in future lessons.

The built-in shutter takes advantage of the large amount of space within the camera body. Since the parts are not restricted to the circular confines around the lens, they can be made comparatively large, rugged, and simple. Or, the parts may remain small and precise while the camera itself is scaled down to pocket-size proportions.

In this lesson, you will examine three variations of the built-in leaf-type shutter. And you'll see how the shutter blades may be located either behind the lens or between the lens elements -- even though the shutter blade driving and timing mechanisms are spread out behind the lens in the camera body.

The Argus C-3, Fig. 2, is a good example of a 35mm camera using a built-in behind-the-lens shutter. In the Argus C-3, almost a third of the volume of the camera body is used to house the shutter mechanism. The result of the Argus design is a shutter that is inexpensive to manufacture, easy to service, and quite dependable -- three factors which contributed to making the Argus C-3 one of the most popular 35mm cameras ever designed.

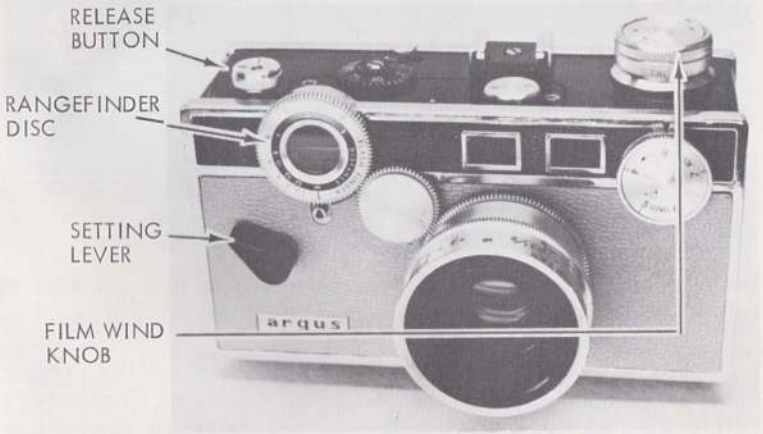


FIGURE 2 ARGUS C-3

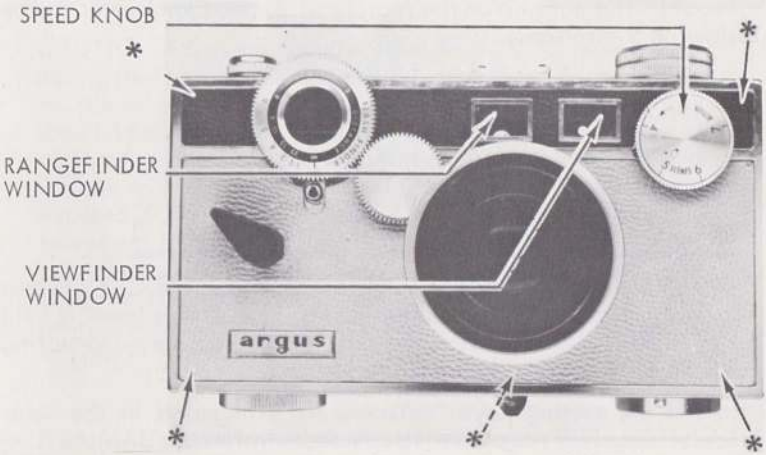


FIGURE 3 *DENOTE FRONT PLATE SCREW POSITIONS

The Argus C-3 has two controls in addition to the setting ever and the release button. One of these controls -- the SPEED KNOB--operates a cam to determine the amount of retard, Fig. 3.

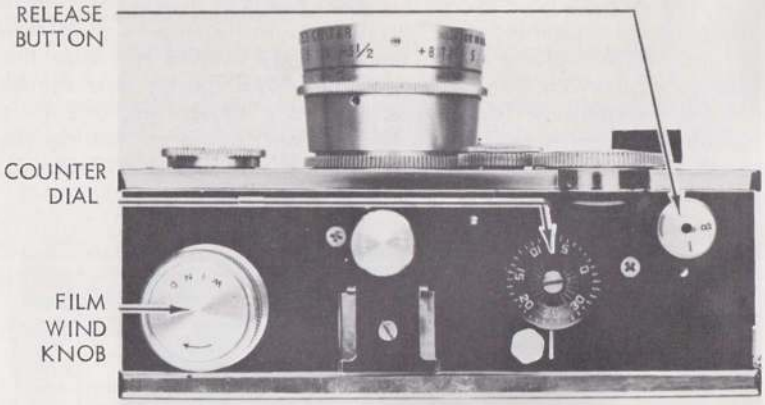


FIGURE 4

The other control permits "bulb" operation -- just turn the knurled release button from "I" (instantaneous) to "B" (bulb), Fig. 4.

Notice that the speed knob, Fig. 3, contains the number calibrations 4 through 8. The particular Argus C-3 illustrated is called the "Matchmatic," a name which refers to the unique method ot calibrating the shutter speeds and the f/stops. Other Argus C-3 models are calibrated in the conventional fractions of a second. The numbers on the Matchmatic speed knob refer to the following shutter speeds:

8 -- 1/300 second
7 -- 1/125 second
6 -- 1/60 second
5 -- 1/30 second
4 -- 1/10 second.

REMOVING THE FRONT PLATE IN THE ARGUS C-3

The front plate assemblies of the various Argus C-3 cameras vary only slightly. In the older models, the setting lever is held by a setscrew. Just loosen the setscrew and unscrew the setting lever in a counterclockwise direction.

But the setting lever setscrew is eliminated in the later models -- such as the camera illustrated. Instead, a JAM NUT -- located immediately under the setting lever, Fig. 5 -- holds the setting lever in place. The setting lever post (on the main lever, as you'll see in a moment) has a left-hand thread. So moving the setting lever counterclockwise to cock the shutter binds the jam nut and the setting lever more tightly against one another

FIGURE 5

Hold the newer-style setting lever stationary with your fingers and turn the jam nut counterclockwise with a thin-headed wrench -- you are now moving the jam nut away from the setting lever. Then, unscrew the setting lever from its post by turning it in a clockwise direction -- and, after removing the setting lever, turn off the jam nut in the same direction.

CAUTION: Do not remove the Argus C-3 speed knob during the front plate disassembly -- the speed knob remains in place on the front plate. In the Matchmatic, the speed knob retaining screw is covered by the cemented calibration plate. But in other models, the screw is visible -- and there's always a temptation to remove an exposed screw. The speed cam -- which controls the movement of the retard section -- is attached to the back side of the speed knob. So by removing the screw, you lose the timing between the speed knob and the speed cam. You can, however, see the proper speed cam timing in figures 7 and 8.

Five or six screws (the number depending on the model) retain the front plate to the camera body. These screws are underneath the leatherette covering the front plate, as indicated by the arrows in figure 3. So carefully lift the leatherette at the four corners of the front plate with your bench knife -- try to avoid tearing or sharply creasing the leatherette.

Another screw is located at the bottom center of the front plate -- as indicated by the dashed arrow in figure 3. And, in some models, there is a sixth screw adjacent to the rangefinder window. You can reach the lower screw without completely removing the leatherette -- either lift the bottom of the leatherette or cut the leatherette as indicated by the dashed arrow, Fig. 3. Make your cut very carefully with the sharp point of your bench knife -- when you later recement the leatherette, the cut will be almost undetectable.

If the sixth retaining screw is used, you can cut the leatherette by the rangefinder window, Fig. 6. Remove all of the flat-headed screws which hold the front plate. Then, carefully lift off the front plate -- be careful you don't drop out the CAM FOLLOWER which remains with the front plate, Fig. 7.

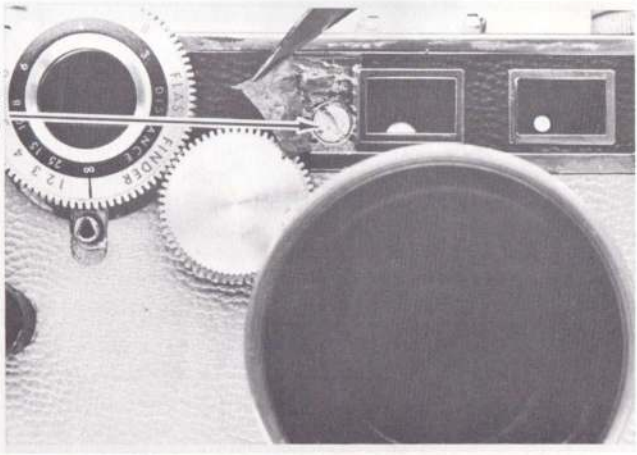


FIGURE 6

CAUTION: The front lens for the eyepiece may be loose once you've removed the front plate. If so, lift out the lens to prevent loss or damage -- the lens sits in the round cavity to the right of the rangefinder assembly, Fig. 10.

Figure 7 shows the inside of the front plate -- here, you can see the speed cam and the cam follower. The pin on the cam follower fits into the hole in the BELL CRANK (in the lower right-hand corner of the camera body, Fig. 9). The bell crank is part of the linkage between the speed cam and the speeds escapement, also pointed out in figure 9.

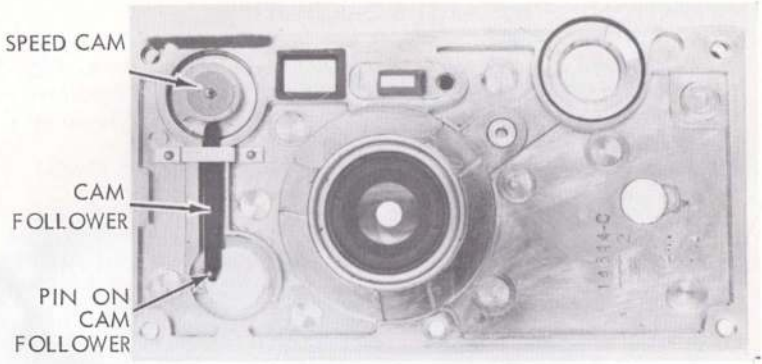


FIGURE 7

SHUTTER SET TO 1/300 SECOND ("8" ON MATCHMATIC)

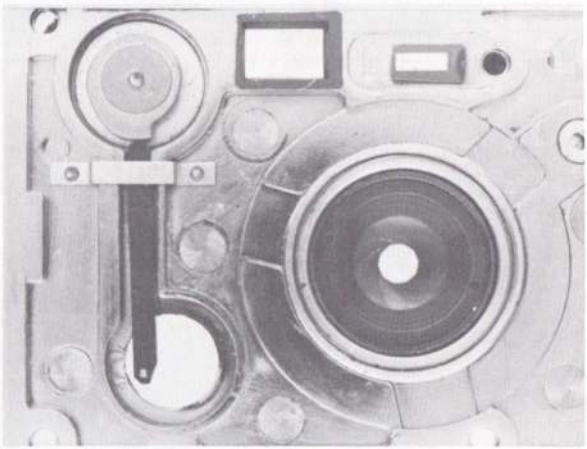


FIGURE 8

SHUTTER SET TO 1/10 SECOND ("4" ON MATCHMATIC)

You'll notice that the cam follower is at its highest position when the camera is set to the fastest shutter speed (1/300 second), Fig. 7. And the cam follower is at its lowest position when the shutter is set to the slowest shutter speed (1/10 second), Fig. 8.

The main lever in the Argus C-3 is a multiple cam, Fig. 9. The SHUTTLECOCK and a long phosphor bronze ribbon -- the SHUTTLECOCK RIBBON -- connect the main lever to the tension-type mainspring.

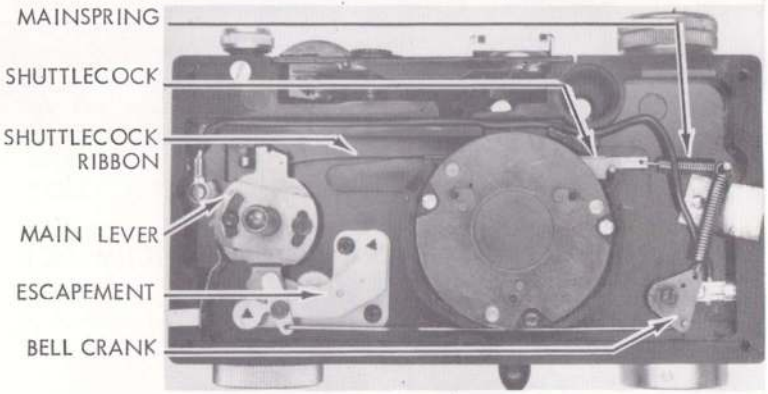


FIGURE 9

To cock the shutter, rotate the main lever in a counterclockwise direction with your finger -- as shown in figure 10. The main lever is then latched in the cocked position by the lower end of the RELEASE PLUNGER, Fig. 11.

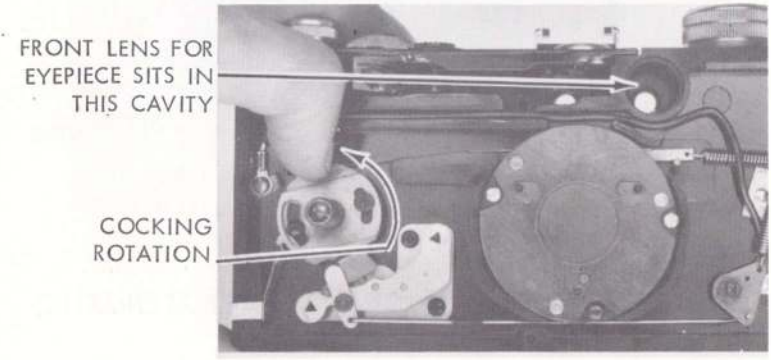


FIGURE 10

Depressing the release button pushes the release plunger down to free the main lever. Now, the mainspring pulls the shuttlecock from left to right, causing the main lever to rotate in a clockwise

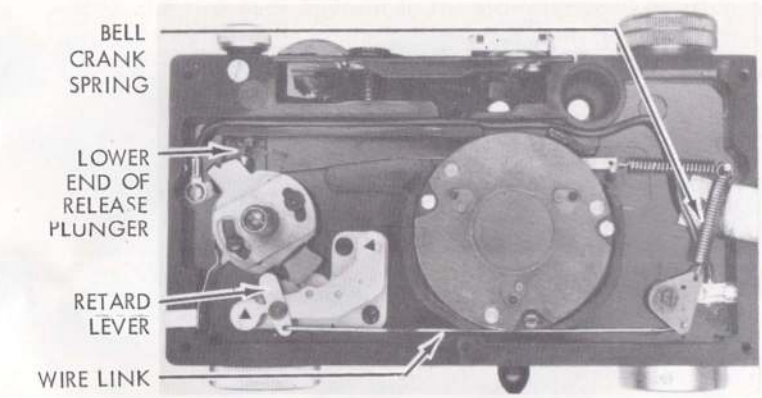


FIGURE 11 SHUTTER COCKED

direction. The shuttlecock assembly, during its release travel, contacts a lug on the blade operating ring to open the shutter blades -- you'll be able to see the action of the shuttlecock more clearly after we remove the shutter blade assembly. A spring on the blade operating ring, not yet visible, then closes the shutter blades.

Since you've removed the front plate -- and, along with it, the speed cam and the cam follower -- the shutter now delivers the fastest speed (1/300 second). The reason is that the bell crank spring, Fig. 11, holds the bell crank all the way in the counterclockwise direction.

Setting slower shutter speeds pushes the bell crank in a clockwise direction -- the speed cam pushes the cam follower down, and the cam follower in turn rotates the bell crank. Notice in figure 11 that a long WIRE LINK connects the bell crank to the RETARD LEVER in the speeds escapement.

In its present position -- 1/300 second -- the retard lever holds the first gear segment (in the speeds escapement) away from the lobe at the bottom of the main lever. But as you select slower speeds, the bell crank pulls the retard lever away from the first gear segment. The first gear segment then turns clockwise, under its own spring tension, as simulated in figure 12 -- now, the pin (on the first gear segment) is in the position to intercept the lobe (on the main lever) during the release cycle.

So the position of the bell crank determines the position of the retard lever -- and the retard lever decides how far the

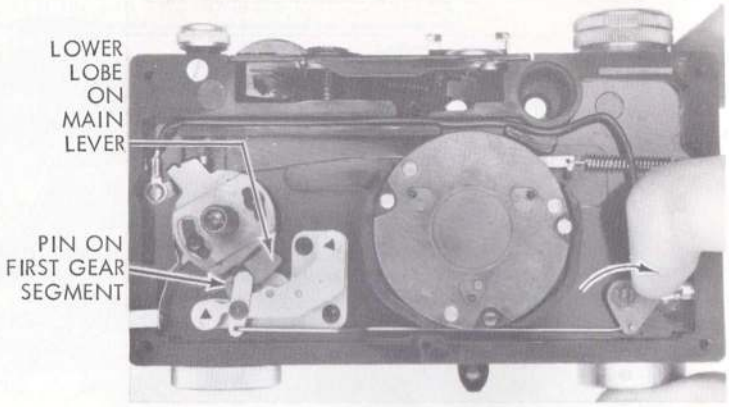


FIGURE 12

first gear segment rotates in a clockwise direction. The farther the first gear segment moves clockwise, the longer it remains in contact with the main lever lobe during the release cycle -- and the slower the resulting shutter speed.

The bell crank pivots on an eccentric bearing which provides an adjustment point for the shutter speeds. You'll adjust the shutter speeds after replacing the front plate -- a hole through the front plate allows you to reach the eccentric bearing, as you'll see a little later.

You can see that the Argus C-3 retard system is quite unlike anything examined in previous systems. But the most unusual part of the whole design is the time at which the retard is introduced. In other shutters we've discussed, the blades open fully before the speeds escapement slows down the main lever -- the escapement then holds the blades fully open for the required length of time. Yet in the Argus C-3, the main lever strikes the first gear segment just as the blades start to open. So the retard is introduced during the blade-opening time -- the slower the shutter speed, the more slowly the blades open.

The position of the pin on the first gear segment at the slowest shutter speed is critical -- careful observation now will help you in adjusting the escapement during reassembly. That is, the speeds escapement has a sliding adjustment -- after loosening the two screws shown in figure 13, you can slide the complete escapement to adjust its position. Referring to figure 13, here's the timing you should note:

With the first gear segment in the slowest-speed position and the main lever in the cocked position, the lobe on the main lever should contact the pin on the first gear segment -- but, at the same time, complete rotation of the main lever must be possible without interference from the first gear segment.

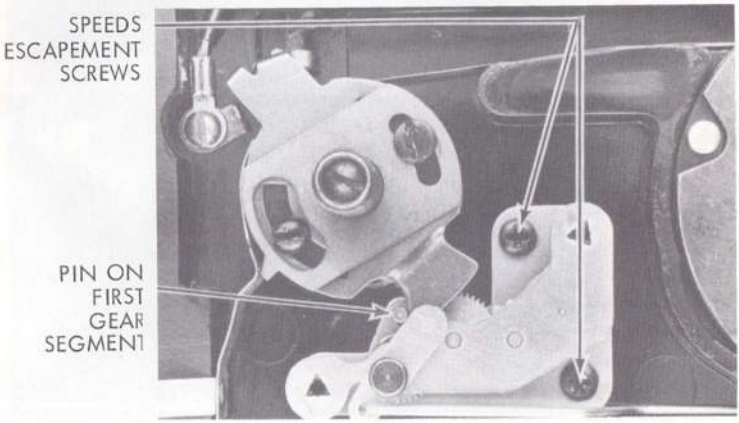


FIGURE 13

To obtain "bulb" action, rotate the release button until its "B" calibration aligns with the index dot on the camera body. Turning the release button to "B" rotates the release plunger to the position shown in figure 14. Now, when you release the shutter, the blades open to the full-open position -- but the flatted

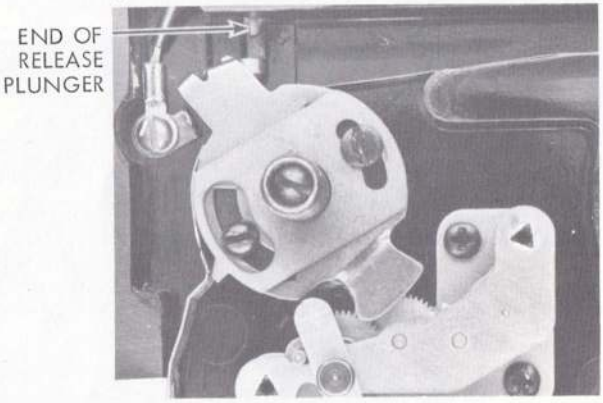


FIGURE 14 SHUTTER COCKED, SET TO "BULB"

end of the release plunger catches the upper lug on the main lever, Fig. 15. Consequently, the main lever is arrested before the shuttlecock has moved far enough for the shutter blades to close. When you let up on the release button, the release plunger frees the main lever--so the main lever completes its rotation and the shuttlecock moves past the lug on the blade operating ring.

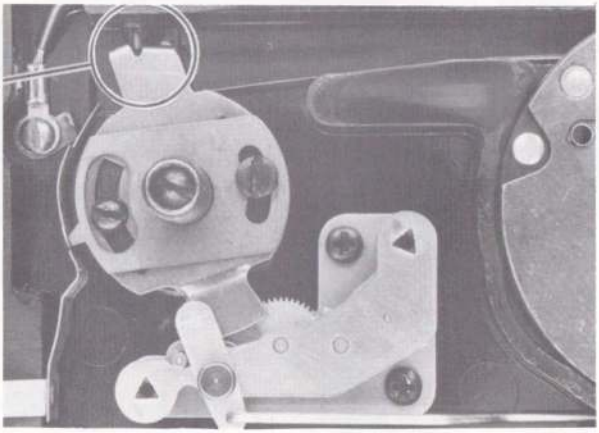


FIGURE 15 SHUTTER HELD OPEN ON "BULB"

DISASSEMBLY OF THE ARGUS C-3 SHUTTER

Remove the shutter blade assembly by taking out the three screws shown in figure 16. Now, on the back of the assembly, you can see the spring-loaded blade operating ring lug that is engaged by the shuttlecock assembly to open the blades, Fig. 17.

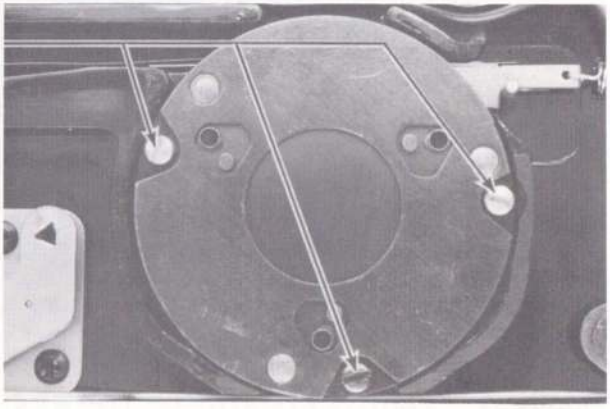


FIGURE 16

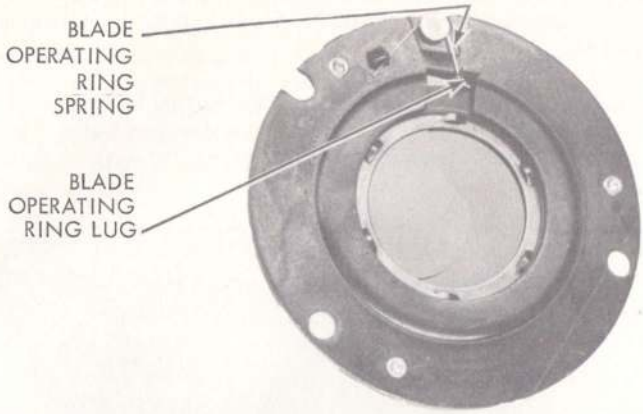


FIGURE 17

The shuttlecock is also clearly visible at this time, Fig. 18. During the cocking cycle, the pivoting action of the spring-loaded SHUTTLECOCK LATCH, Fig. 18, allows the latch to bypass the blade operating ring lug --but on the release cycle, the shuttlecock latch engages the lug and drives the blades to the open position.

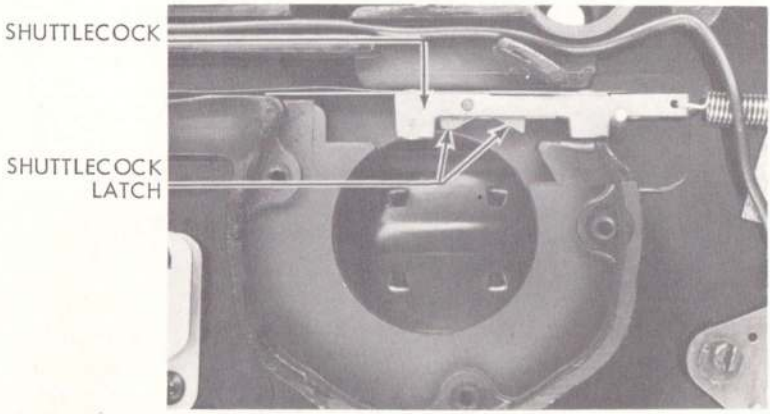
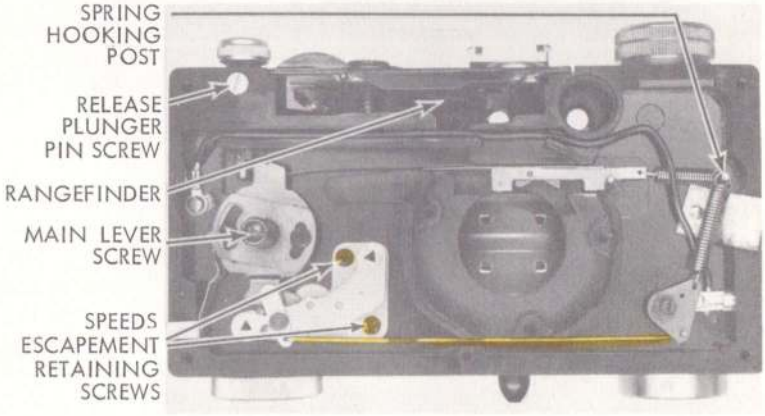


FIGURE 18

Now, disconnect the wire link from the retard lever. Remove the two screws shown in figure 19 and lift out the entire speeds escapement.

Disconnect the two tension springs -- the bell crank spring and the mainspring -- from the post on the camera body, Fig. 19. Remove the main lever by taking out the screw through its threaded post, Fig. 19.



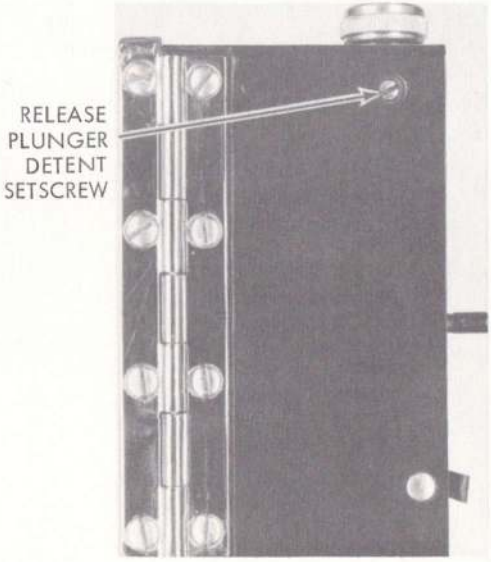


FIGURE 20

To remove the release plunger, first take out the setscrew at the end of the camera body, Fig. 20 -- but be careful: a spring and a ball detent remain inside the cavity. The ball detent acts on the rotating part of the release plunger assembly, holding it in either the "I" or the "B" position; and the setscrew you just removed determines the amount of spring tension on the detent. You can now remove the spring and the ball detent from the setscrew cavity.

Remove the brass pin screw at the front of the camera, Fig. 19, and lift out the release plunger. The release plunger is a complete unit which does not require further disassembly.

As we mentioned earlier, the bell crank pivots on an eccentric bearing. The eccentric bearing is pointed out in figure 21; the screw, also seen in figure 21, both holds the adjustment of the eccentric bearing and retains the bell crank. To take out the bell crank, remove the screw and the eccentric bearing. Now, lift out the bell crank and the wire link -- you'll have to adjust the eccentric bearing on reassembly to time the shutter speeds.

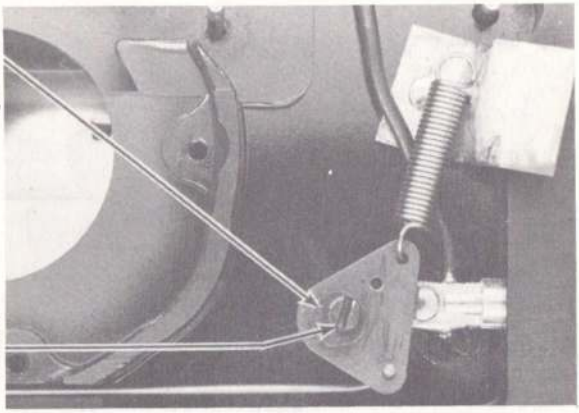


FIGURE 21

You will rarely have to disassemble the camera any further than we have just done -- at least to service the shutter. The disassembly and adjustment of the rangefinder, pointed out in figure 19, is covered in a later lesson -- avoid disturbing the rangefinder at this time.

REASSEMBLY OF THE ARGUS C-3 SHUTTER

Replace the bell crank and the wire link as one assembly. Then, seat the eccentric bearing and replace the retaining screw

-- make sure the eccentric shoulder on the bearing passes through the hole in the bell crank. While tightening the screw, check to assure that the bell crank pivots freely.

Insert the release plunger assembly through its hole at the top of the camera -- the elongated slot in the release plunger (which receives the brass pin screw) must be to the front of the camera. Then, replace the brass pin screw from the front of the camera.

The release plunger should now rotate freely between the "B" and "I" positions -- remember, the ball detent and spring hold the release plunger at either setting. Place first the ball detent, and then the spring, into the cavity at the end of the camera body. Then, tighten the setscrew until you feel the two solid "click-stop" positions of the release plunger.

Before replacing the main lever and shuttlecock assembly, examine the joint between the shuttlecock ribbon and the main lever, Fig. 22. You can see that the shuttlecock ribbon is soldered within a slot in the body of the main lever. Replacing a broken shuttlecock ribbon is one of your more common repairs in the Argus C-3.

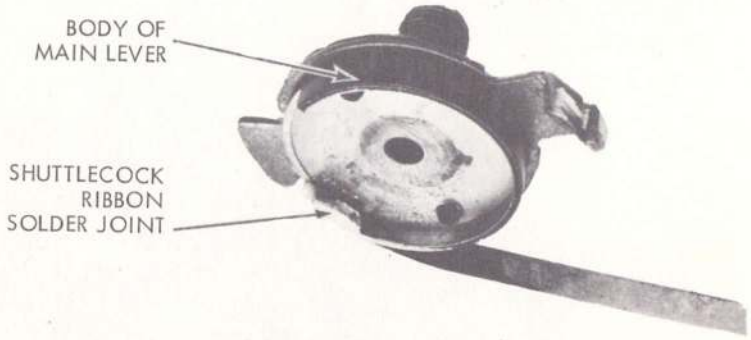


FIGURE 22 UNDERSIDE OF MAIN LEVER

Handle the shuttlecock ribbon very carefully as you lower the main lever into position. Accidentally placing a kink in the shuttlecock ribbon could cause the metal to fail during the shutter operation. When the assembly is fully seated, replace the main lever retaining screw and hook the end of the mainspring over its post. Test the movement of the main lever by cocking and releasing the shutter several times.

Hook the end of the bell crank spring over the post on the camera body. Now, cock the shutter and seat the speeds escape-

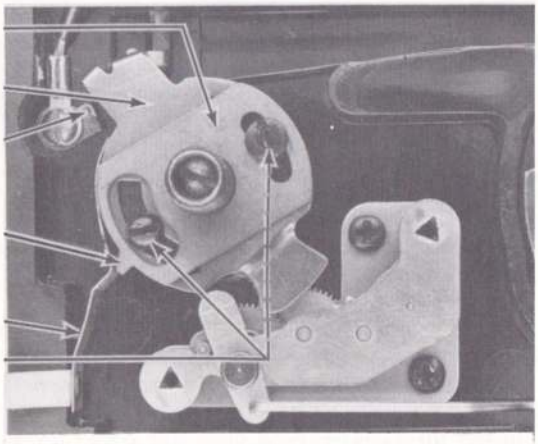
ment in position. Make sure that both the main lever lobe and the retard lever (with its hole end down) are to the right of the stud on the first gear segment. Then, replace the two screws holding the speeds escapement.

Before tightening the two screws, adjust the speeds escapement to the position shown in figure 13. Then, tighten the two screws to hold the adjustment. Check your adjustment by cocking and releasing the shutter several times -- the stud on the first gear segment must not slip past the main lever lobe as you cock the shutter. When you're sure the retard position is correct, hook the end of the wire link to the hole in the retard lever.

As you seat the shutter blade assembly, make sure the stud on the blade operating ring is toward the top of the camera. Then, replace the three retaining screws -- the long screw goes to the bottom of the shutter blade assembly.

ADJUSTMENTS ON THE ARGUS C-3 MAIN LEVER

We mentioned earlier that the main lever is a multiple cam. Actually, the main lever is in three separate parts -- and the relationships of these parts to one another may require adjustment on reassembly. The two screws provided at the front of the main lever, Fig. 23, hold the sections of the main lever together as one piece -- but by loosening the screws, you can reposition each part of the main lever.



The three sections of the main lever are: the main BODY which secures the shuttlecock ribbon, Fig. 22; the RELEASE CAM which engages the release plunger and the pin on the first gear segment, Fig. 23; and the SYNC CAM which closes the internal sync contacts, Fig. 23. To adjust the release cam, you must loosen both of the screws shown in figure 23. But to adjust the sync cam, just loosen the one screw indicated by the dashed arrow.

First, let's check the adjustment of the release cam. Cock the shutter and set the release plunger to "bulb." Now, release the shutter and hold the release button depressed -- the shutter blades should remain fully open. But if the release cam is out of adjustment, the shutter blades either will fail to remain open on "bulb," or will open only part way.

Say, for example, that the shutter blades remain partially open on "bulb" -- this means that the main lever is blocked by the release plunger before rotating far enough to allow full blade opening.

The correction is to continue holding the shutter open on "bulb" and loosen the two screws, Fig. 23 -- loosening the screws allows the body of the main lever to turn separately from the release cam. Now, while the release cam remains held by the release plunger, allow the body of the main lever to rotate slowly (clockwise) until the blades are fully open -- then, retighten the screws. As the body of the main lever turns clockwise, the shuttlecock ribbon moves farther to the right -- and that allows the shuttlecock to open the blades the additional amount.

The other symptom of maladjustment is that the blades open and close before the release cam is arrested by the release plunger. Consequently, the shutter delivers an instantaneous speed when set to "bulb." The correction is to loosen the two screws and turn the body of the main lever counterclockwise in relation to the release cam.

Once you've adjusted the release cam at "bulb," you can check the timing of the sync cam. Since only one of the two screws in figure 23 holds the sync cam, adjusting the flash sync doesn't disturb the release cam adjustment.

Compared to some of the other shutters you've studied, the operation of the Argus C-3 flash sync is quite simple. Locate the lug on the sync cam in figure 23 -- as the main lever revolves in the release (clockwise) direction, this lug strikes the movable sync contact. The sync cam lug then pushes the movable sync contact against the fixed sync contact to fire the flash.

By loosening the sync cam screw, Fig. 23, you can move the sync cam to change the time at which the flash is fired. Here, you have a wide adjustment range -- by just turning the sync cam, you can change the sync delay all the way from "F" sync to "X" sync.

Most Argus C-3's are set for "F" sync -- that is, the contacts close to fire the flash just before the shutter blades start to open. The actual delay is then the time it takes for the blades to reach the full-open position. But if your customer wants you to convert his Argus C-3 to "X" sync for electronic flash, all you have to do is turn the sync cam until the contacts close when the blades reach the full-open position.

REPLACING THE FRONT PLATE AND ADJUSTING THE SHUTTER SPEEDS IN THE ARGUS C-3

When either the speeds escapement or the bell crank has been removed, you must readjust the shutter speeds. Strip back the leatherette from the lower right-hand corner of the front plate to reveal the inspection disc, Fig. 24. By removing the inspection disc, you can reach the eccentric bearing on the bell crank.

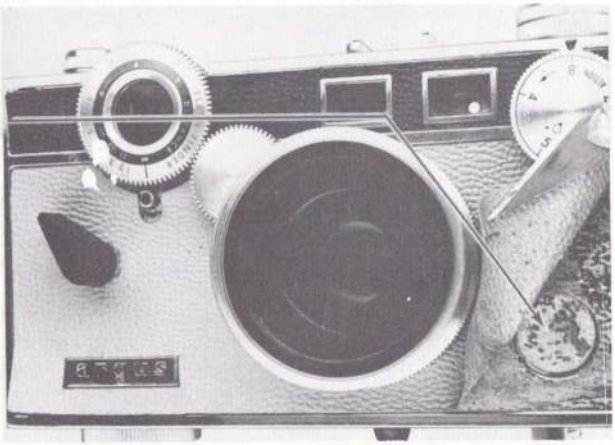


FIGURE 24

Set the speed cam at the highest speed (for ease of alignment) and fit the cam follower in position, Fig. 7. Now, seat the front plate on the camera body -- you can work through the inspection hole in the front plate to fit the cam follower pin into the bell crank hole. Then, replace the screws holding the front plate --

the long screw, if there is one, goes beside the rangefinder window.

Depress the release button to make sure the shutter is in the released position. Now, replace the setting lever -- remember, the setscrew-type has a right-hand thread, while the jam-nut type has a left-hand thread. If you're installing the setscrew-type, turn the setting lever clockwise as far as it will go. Then, back off the setting lever until it points to 10:30 o'clock, Fig. 25, and tighten the setscrew.

But if you're installing the jam-nut type, first screw on the jam nut in a counterclockwise direction as far as it will go. Then, turn the setting lever all the way down to the jam nut. Back off the setting lever to 10:30 o'clock, Fig. 25. While holding the setting lever in position, use a thin-headed wrench to turn the jam nut clockwise -- until the jam nut is tight against the underside of the setting lever.

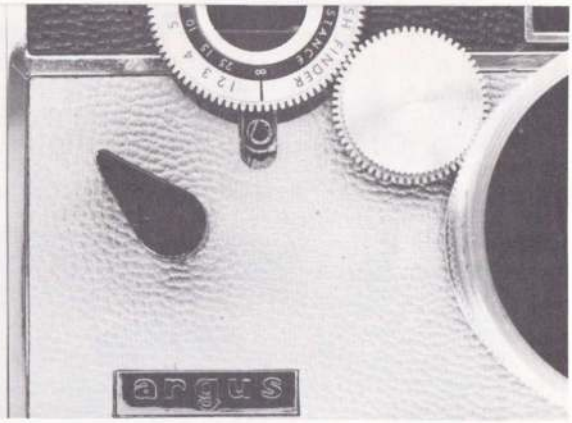


FIGURE 25 TIMING OF SETTING LEVER

You can now make a fairly accurate adjustment of the speeds by just listening to the retard action. At the fastest shutter speed, there should be no retard action -- and there should be just a trace of retard at the next-to-the-highest speed.

Cock the shutter and set the speed knob to the fastest speed (1/300 second). Now, while restraining the setting lever to slow down the main lever's rotation, push the release button. As you allow the main lever to run slowly through its cycle, listen for the sound of the retard.

If you can detect retard engagement at 1/300 second, you must adjust the eccentric bearing. Working through the inspection

hole in the front plate, loosen the bell crank screw and turn the eccentric bearing. Set the eccentric bearing so you can hear no retard action at the fastest speed, and just a trace of retard at the next-to-the-highest speed.

But if you can't get enough adjustment out of the eccentric bearing, you may have to bend the wire link to change its effective length. Shortening the wire link provides less retard, and lengthening the wire link provides more retard. Bending the wire link is a rough adjustment for the shutter speeds -- you can then make fine adjustments by turning the bell crank lever eccentric.

When you're sure everything is working properly, recement the leatherette. Pliobond, a rubber-base cement, works well for this purpose. Apply a thin film of Pliobond to both surfaces -- the camera body and the back of the leatherette -- and allow the cement to dry until it is tacky. Be sure your cement is applied evenly -- "lumps" of excessive cement can damage certain types of leatherette. Then, press the leatherette to the camera body.

THE ARGUS C-4 SHUTTER

A more refined camera using the built-in behind-the-lens shutter is the Argus C-4, Fig. 26. But the shutter in the Argus C-4 bears little other resemblance to the C-3 design you just studied.

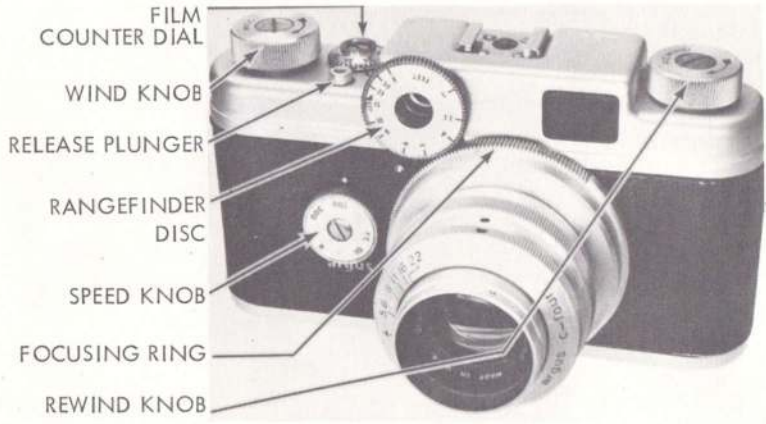


FIGURE 26 ARGUS C-4

Three other Argus cameras use the same shutter design as we find in the C-4. The Argus 21 just lacks the built-in rangefinder. The Argus C-44 adds the feature of interchangeable lenses; and the Argus C-44R, the top of the line, replaces the wind knob with the more-convenient rapid-wind lever.

REMOVING THE ARGUS C-4 SHUTTER ASSEMBLY

Reaching the built-in Argus C-4 shutter involves a very straightforward disassembly. So we'll just outline the procedure here. First, remove the screw holding the wind knob. Lift off the wind knob and take out the two screws holding the wind knob seat (underneath the wind knob). You can now lift off the wind knob seat and the brass wind shaft with its compression spring.

Take off the rewind knob by removing its center screw. Now take out the two screws holding the spacer around the rewind shaft.

One screw holds the film counter dial. Remove the screw and lift off the dial -- the washer and compression spring, sitting underneath the film counter dial (with the washer on top of the spring) can then be removed.

Lift the top cover plate high enough to see where the sync wires are soldered, Fig. 27. Note the positions of the wires by their color codes -- then, unsolder the three wires and remove the top cover plate. Lift off the loose spacer which sits around the rewind shaft, Fig. 27.

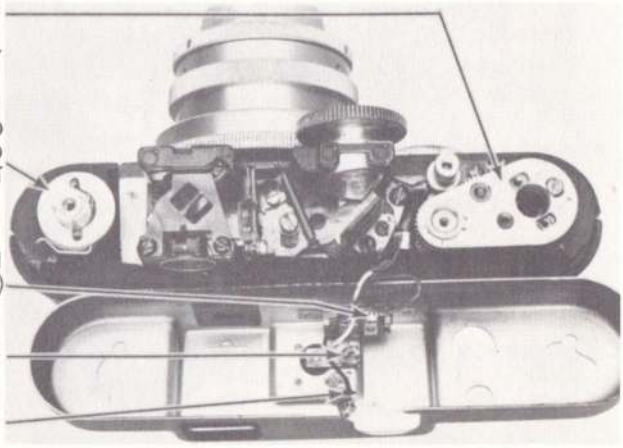


FIGURE 27

Only one screw still holds the upper gear train assembly, Fig. 27, at the wind-knob end of the camera body. The two screws holding the wind lever seat (which you removed earlier) also thread through the upper gear train assembly. By just loosening the remaining screw, you can slide the complete upper gear train assembly in position -- this is a depth-of-engagement adjustment which influences the "feel" of the wind stroke. In other words, if the camera winds too hard, the depth of engagement may be too deep.

Make a note of (or scribe) the positioning of the upper gear train assembly -- then, take out the one remaining screw and lift off the complete assembly. The idler gear, which is now loose, sits collar-up over the post on the upper gear train mechanism plate.

NOTE: Turning the wind knob to cock the shutter rotates the sprocket through the upper gear train. So, with the wind knob removed, you can cock the shutter just by turning the sprocket. You'll see how the sprocket cocks the shutter a little later in the disassembly.

Turn the base lock on the bottom of the camera in the "open" direction and remove the camera back. Next, remove the pin screw shown in figure 28 -- this screw holds the lens assembly to the FOCUSING RING. After removing the pin screw, simply unscrew the lens assembly in a counterclockwise direction.

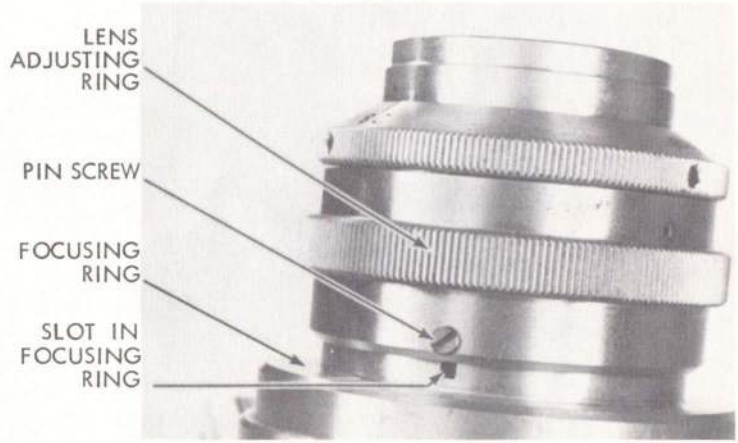


FIGURE 28

NOTE: On reassembly, you'll have to adjust the lens for proper focus. Although lens focusing procedures are covered later in your course, we'll describe the procedure for the C-4 in this text.

The pin screw you just removed keys into a slot in the focusing ring. And the focusing ring gears to the RANGEFINDER DISC, Fig. 26. For reassembly reference on the timing between the focusing ring and the rangefinder disc, set the rangefinder disc to the infinity position. Notice that the last tooth at the left-hand end of the focusing ring geared rack now engages the rangefinder disc -- that is, when the infinity calibration on the rangefinder disc aligns with the index dot on the camera front plate.

Remove the retaining ring that holds the focusing ring in place. Now, lift off the focusing ring.

You must peel back the front leatherette on each side of the lens mount to reach the four screws holding the camera front plate assembly. You'll find, however, that it's often difficult to remove the leatherette without damage -- even though you're very careful. So if you do much Argus C-4 work, you might find it desirable to keep some new leatherette in stock.

After removing the front leatherette, take out the four front plate retaining screws. Then, lift out the complete front plate/-shutter assembly as one unit. Figure 29 shows the front plate/shutter assembly removed from the camera body.

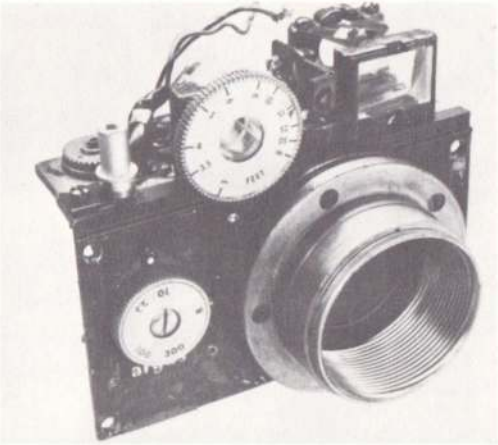


FIGURE 29 FRONT PLATE/SHUTTER ASSEMBLY

At this stage of disassembly, you can cock and release the shutter to examine the operations of the various parts. Cock the shutter by turning the sprocket with your finger -- turn the sprocket in the direction shown in figure 30 until it stops. Release the shutter by pushing down the release plunger, Fig. 30.

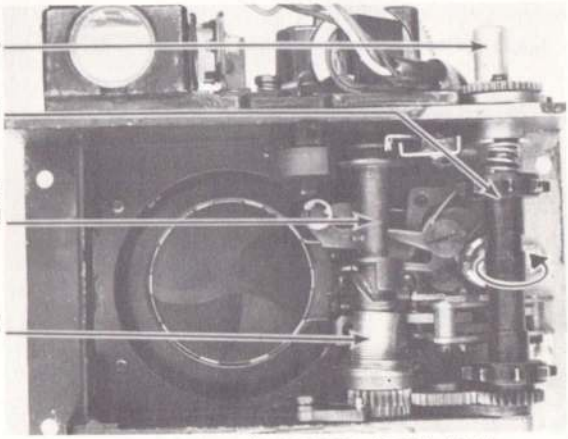


FIGURE 30 BACK OF FRONT PLATE/SHUTTER ASSEMBLY

Now, try turning the sprocket in the direction opposite to the curved arrow in figure 30 -- notice that the SLIDE PLATE underneath the sprocket swings toward the front of the camera, Fig. 31. As it moves, the slide plate carries the idler gear out of engagement with the MAIN WIND GEAR, Fig. 31. So the sprocket turns freely in a clockwise direction (as seen from the top of the camera) while you are rewinding the film into the 35mm cassette. To rewind the film, just lift up on the wind knob (to disengage the upper gear train) and turn the rewind knob in the direction of its arrow, Fig. 26.

You'll learn more about film wind and film metering mechanisms in a later lesson. For now, remember that the sprocket turns in one direction -- indicated by the curved arrow in figure 30 -- to advance the film to the next frame and to cock the shutter. But the sprocket must be able to turn freely in the opposite direction as you rewind the film into the cassette (prior to removing the film for processing).

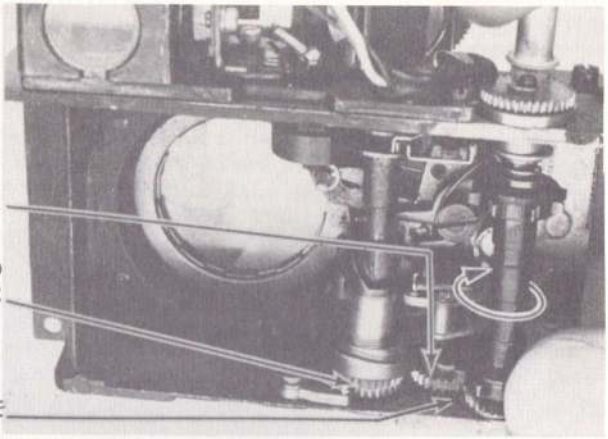


FIGURE 31 REWIND CYCLE

The main lever in the Argus C-4 is actually a shaft rather than a lever. So we refer to the main lever as the MAIN DRIVE COLUMN in figure 30. The mainspring is the torsion-type spring sitting at the bottom of the main drive column -- notice that a lug at the bottom of the main drive column hooks the upper end of the mainspring, Fig. 32.

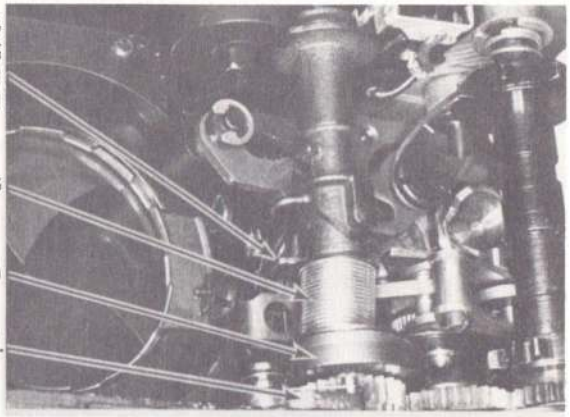


FIGURE 32

The other (lower) end of the mainspring hooks within a notch in the WIND CAM, Fig. 32. And the wind cam is attached to the main wind gear, the large brass gear we examined earlier. The spring-loaded pawl mounted to the bottom of the shutter assembly engages the teeth of the main wind gear -- this pawl assures that the main wind gear can only turn in one direction.

Now, with the shutter in the released position, notice that the main drive column is latched by the RELEASED-POSITION LATCH, Fig. 33. The released-position latch is the part that prevents the mainspring from turning the main drive column in the release rotation (the release rotation is indicated by the curved arrow in figure 33). Even though the shutter isn't cocked, there is a certain amount of tension on the mainspring -- this is the INITIAL TENSION. If you remove the mainspring, as we'll later describe, you must replace the correct amount of initial tension on reassembly.

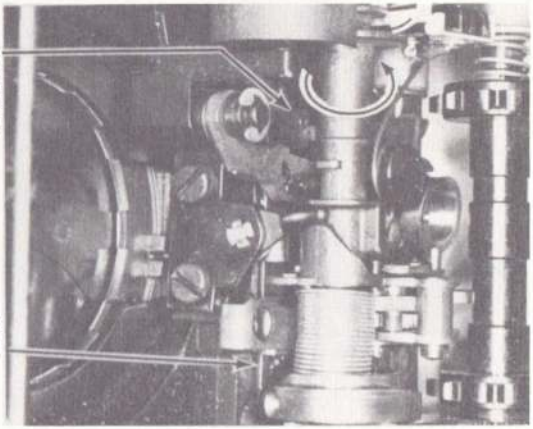


FIGURE 33 RELEASED POSITION

The position of the main drive column when the shutter is cocked is only slightly different from that shown in figure 33. If you'll slowly rotate the sprocket in the cocking direction, Fig. 30, you can see the main drive column jump slightly in the direction of the curved arrow in figure 33 -- this slight movement indicates that the main drive column is now in its "ready" position.

Let's follow through the cocking cycle to see how the main drive column moves from its released position (held by the released-position latch) to its "ready" position. As you turn the sprocket in the film-advance direction, the gear on the bottom of the sprocket turns the idler gear. The idler gear then turns the main wind gear to rotate the wind cam and tension the mainspring.

During the cocking rotation, the cam surface on the wind cam raises the TRANSFER SHAFT, Fig. 33 -- that is, pushes the transfer shaft toward the top of the camera. The upper end of the transfer shaft then pushes the released-position latch up to disengage the main drive column.

The main drive column now starts to turn in its release rotation. But the upward movement of the transfer shaft also allows the INNER RELEASE LEVER to move up. Notice in figure 34 that a pin on the transfer shaft rides within a cutout in the inner release lever -- so the transfer shaft controls the position of the spring-loaded inner release lever.

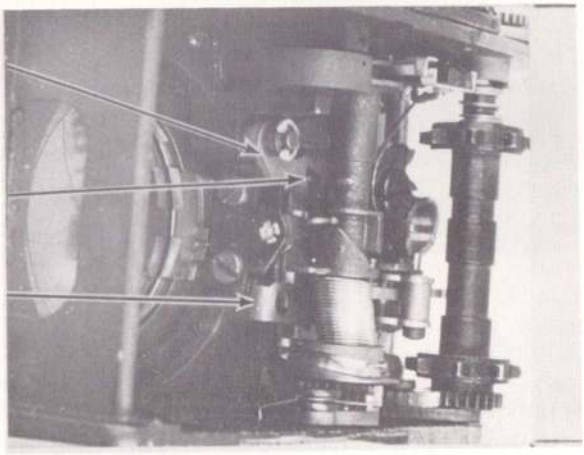


FIGURE 34 "READY" POSITION

Now, the inner release lever swings into position to intercept the release rotation of the main drive column. The main drive column can turn only a slight distance before it is latched by the inner release lever, Fig. 34. And the spring-loaded released-position latch is then held against its tension by the lug on the main drive column (the same lug that the released-position latch formerly engaged and is now engaged by the inner release lever).

You can continue turning the sprocket in the film-advance direction until the lower end of the transfer shaft blocks the lug on the wind cam -- when the transfer shaft is pushed up by the wind cam, it comes into position to block the wind cam at the end of the cocking cycle. The transfer shaft is held in its "up" position by the tension on the spring clip, Fig. 34.

The shutter is now in the fully-cocked position: the wind cam is blocked by the transfer shaft (after the sprocket has metered off the correct amount of film) and the main drive column is latched by the inner release lever (rather than by the released-position latch).

When you release the shutter, the release plunger pushes the inner release lever out of engagement with the main drive column.

Now, the main drive column spins in its release rotation. As soon as the latching lug on the main drive column passes from underneath the released-position latch, the spring-loaded released-position latch pushes the transfer shaft back down -- the lower end of the transfer shaft then falls below the lug on the wind cam, freeing the wind cam prior to the next cocking cycle.

Now, the released-position latch is in position to catch the latching lug on the main drive column. So the main drive column spins in its release rotation until the latching lug once again strikes the released-position latch, Fig. 33.

As the main drive column turns in the release rotation, it drives the blade operating ring to open and close the shutter blades. The link between the main drive column and the blade operating ring is the LEAF LEVER, Fig. 35 (called the "TOGGLE PLATE" by Argus). Notice that one end of the leaf lever rides within the cam groove in the main drive column -- the other end of the leaf lever engages the blade operating ring.

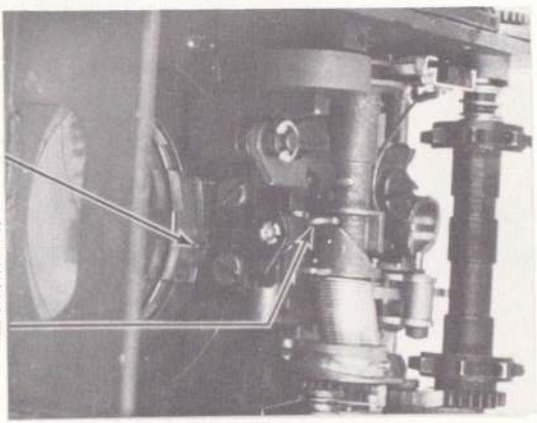

THIS END OF LEAF LEVER ENGAGES FORKED TAB OF BLADE OPERATING RING
THIS END OF LEAF LEVER RIDES IN CAM GROOVE IN MAIN DRIVE COLUMN

FIGURE 35

As the main drive column turns, it drives the leaf lever first up (to open the blades), and then down (to close the blades). But the main drive column turns only in one direction -- counterclockwise, as seen from the top of the camera.

Different instantaneous speeds are obtained by retarding the main drive column's rotation when the blades reach the full-open position. Locate the speeds escapement which is riveted to the camera body, Fig. 36. Once the main drive column has turned far enough to open the blades, its RETARD DRIVING LUG (the same lug which hooks the mainspring) strikes the pin on the first

gear segment. The speeds escapement then slows down the rotation of the main drive column to hold the blades open.

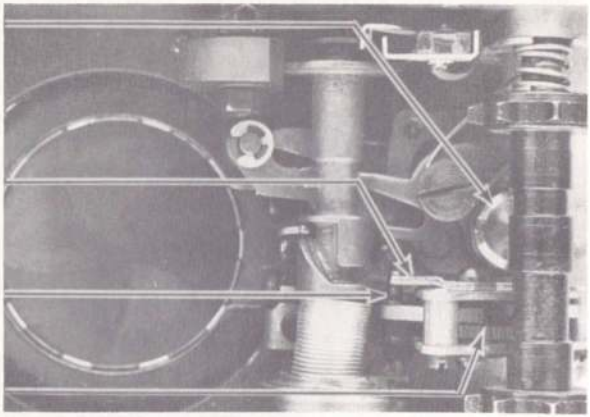


FIGURE 36

We can change the amount of retard by turning the speed knob on the front of the camera. The speed knob turns the speed cam, Fig. 36, to control the position of the retard lever. And the retard lever, in turn, controls the position of the spring-loaded first gear segment.

Notice that the speed cam also controls the position of the BULB LEVER, Fig. 37. At all of the instantaneous speeds, the speed cam holds the latching end of the bulb lever down --away from the BULB LUG on the main drive column.

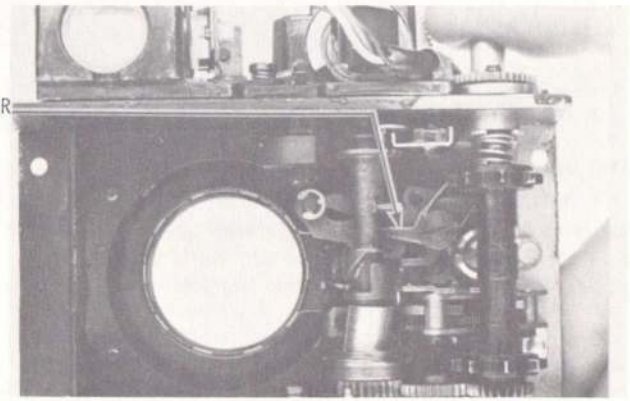


FIGURE 37 SHUTTER HELD OPEN ON "BULB"

But at the "bulb" setting, Fig. 37, the speed cam allows the spring-loaded bulb lever to swing up. Now, when you release the

shutter the inner release lever pushes the bulb lever down slightly, into the path of the bulb lug on the main drive column. So as the main drive column rotates and opens the blades, the latching end of the bulb lever catches the bulb lug. The bulb lever then prevents the main drive column from completing its rotation (to close the blades) as long as you hold the release plunger depressed.

When you let up on the release plunger, the inner release lever frees the bulb lever -- the bulb lever spring then pulls the bulb lever up to disengage the main drive column.

The one remaining function of the main drive column involves the operation of the sync contacts. The CONTACT CLOSING CAM at the top of the main drive column and the STAR WHEEL CAM just below the contact closing cam control the sync delay and the contact closure, Fig. 38.

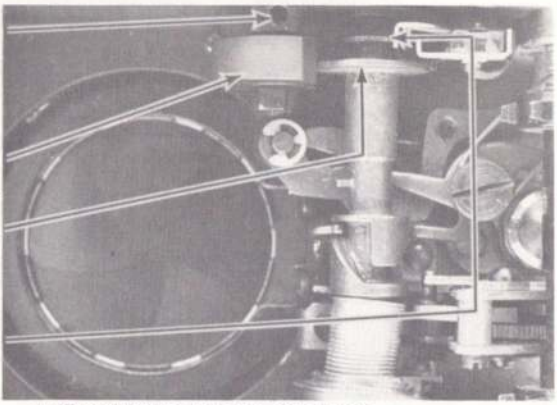


FIGURE 38 *DESCRIBED LATER IN TEXT

In the Argus C-4, you have a choice between either "M" sync or "X" sync (or, in some models, between "F" sync and "X" sync) -- you learned the meaning of these terms in your lesson, "Complex Escapement Retard Shutter -- Part I." Both sync delay times are provided by the CONTACT BLOCK shown in figure 39 -- and the switch on the camera top cover plate (from which you unsoldered the sync wires) electrically determines which sync action is delivered.

On "M" sync, as you know, the flash is fired and the shutter opening is delayed for a fraction of a second while the flashbulb reaches its peak intensity. In the Argus C-4, the delay is provided by the SYNC PALLET which engages the teeth cut in the star

wheel cam, Fig. 38. So the sync pallet delays the rotation of the main drive column while the flashbulb reaches its peak intensity.

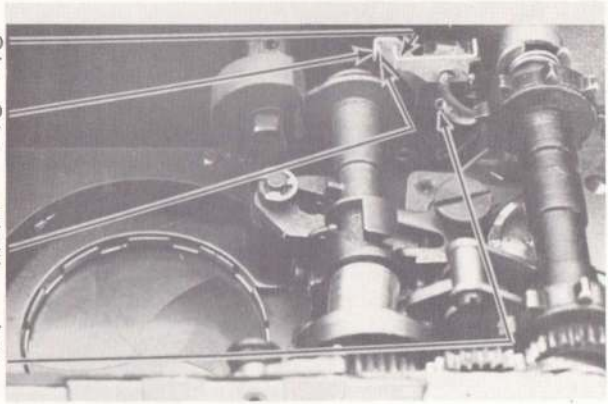


FIGURE 39

You can see the contact closure by using your finger to restrain the release rotation of the main drive column. Notice that as the main drive column first starts to turn, the contact closing cam pushes the MOVABLE CONTACT BLADE against the fixed "M" contact, Fig. 39. During this rotation, the sync pallet slows down the movement of the main drive column.

Then, as the main drive column continues its rotation, the contact closing cam frees the movable contact blade. The movable contact blade swings to its left (under its own tension) to strike the fixed "X" contact once the blades are fully open.

At the last degree of main drive column rotation, the sync cam pushes the movable contact blade away from the fixed "X" contact to break the "X" flash sync circuit. Even though both the "M" and the "X" contacts close during every shutter operation, only one sync time is provided -- depending on the position of the sync switch on the top cover plate.

DISASSEMBLY OF THE ARGUS C-4 SHUTTER

As it now stands, the Argus C-4 shutter is easily accessible for routine cleaning and lubrication. However, you'll frequently have to go a little further in disassembly and remove the shutter blades, the leaf lever, and the main drive column. The reason is that dirt and grease may cause the shutter blades to stick together -- and operating the shutter with "frozen" shutter blades often causes additional damage.

For example, the mainspring may be distorted (or may break) -- or the leaf lever may break from the strain. So you'll have to disassemble the shutter blade assembly to clean the blades and the blade operating ring -- and you may have to remove the main drive column to replace the mainspring.

The shutter blade assembly is held by screws coming either from the front or from the back of the assembly -- the way in which the shutter blade assembly is mounted depends on the particular model. If the retaining screws come in from the back, the shutter blade assembly comes off as a complete unit. But if the screws come in from the front, as in our example, the many individual parts of the shutter blade assembly are loose after removing the screws. So you must be very careful during disassembly to note the positions of the individual parts.

Lay the camera on your workbench with the lens mount facing you, as in figure 40. Now, remove the five screws pointed out in figure 40 --be careful that you don't disturb the shutter blade assembly.

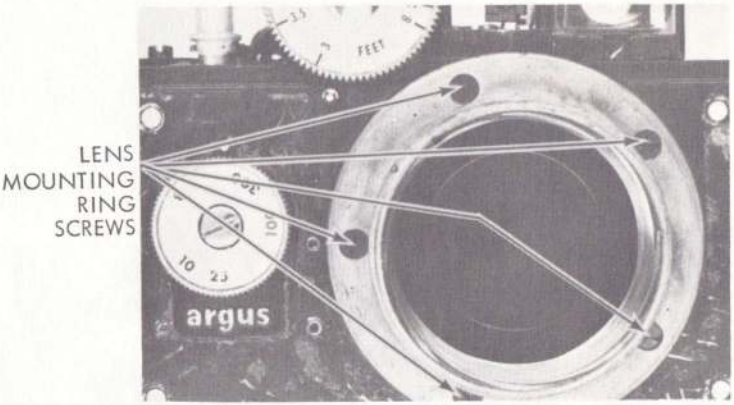


FIGURE 40

Then, lift off the lens mounting ring, placing it on your workbench. Next, lift off the first plate, Fig. 41, and place it next to the lens mounting ring. Lift off the second plate, Fig. 42, placing it next to the first plate -- you can now see the shutter blades and the brass blade spacers over the screw holes, Fig. 43. Lift out the shutter blades and the five blade spacers (which just provide clearance for the shutter blades).

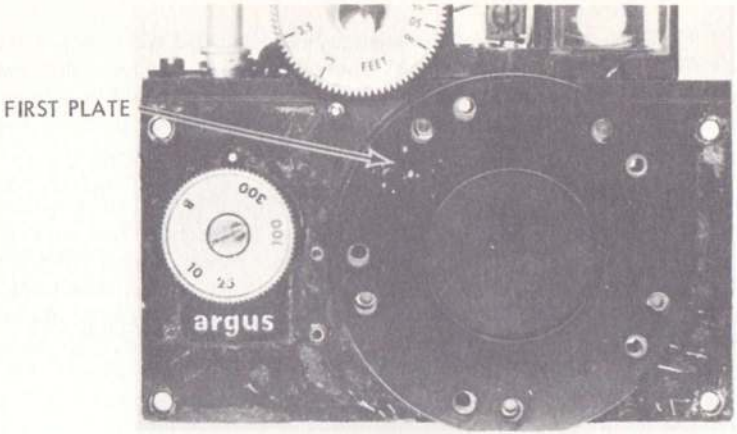


FIGURE 41

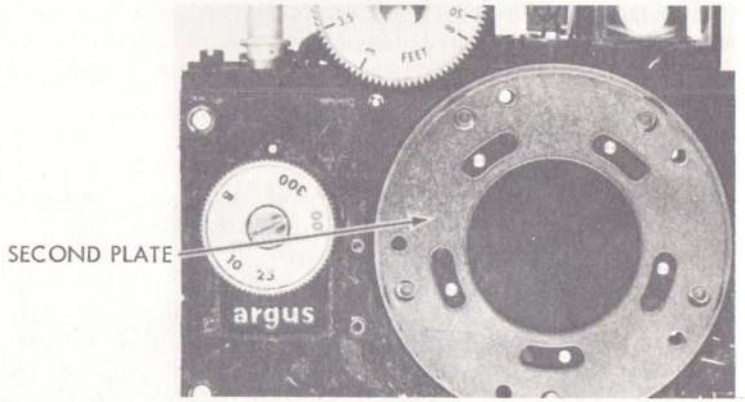


FIGURE 42

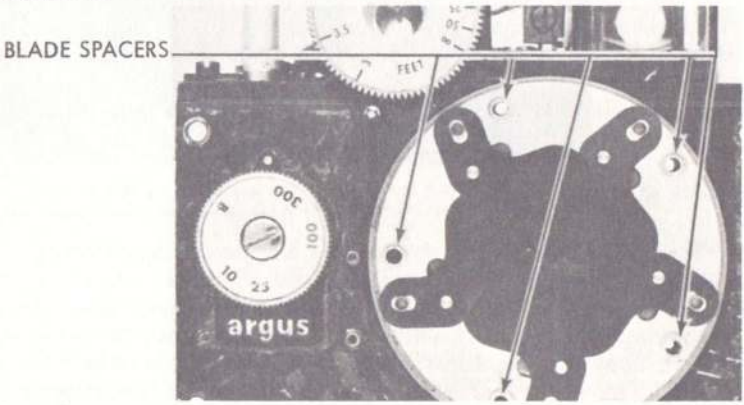


FIGURE 43

Next, lift off the shutter blade mounting plate, Fig. 44, and the blade operating ring, Fig. 45. Remove the brass plate and the black base plate, Fig. 46, in that sequence -- remember, keep these parts in order for reassembly. Figure 46 also points out the end of the leaf lever that engages the forked tab on the blade operating ring.

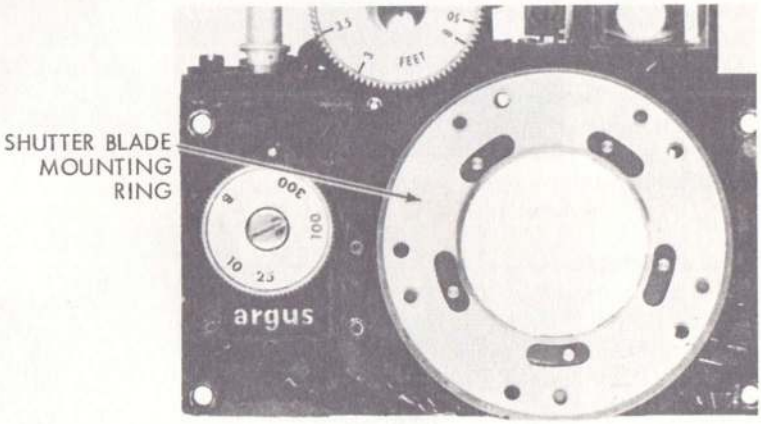


FIGURE 44

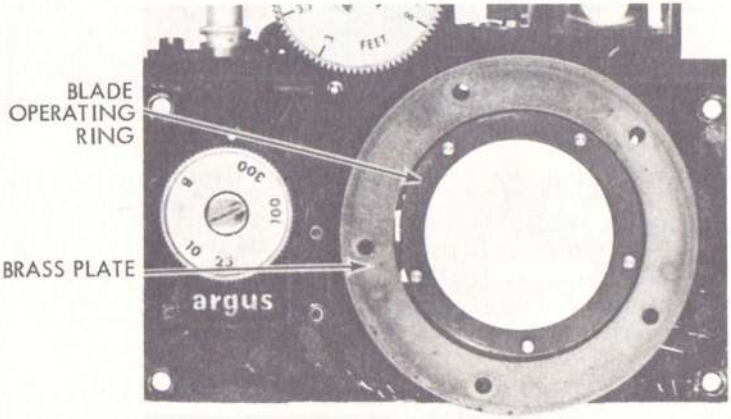


FIGURE 45

You can now see the five spacers sitting within the holes in the felt pad, Fig. 47 -- lift out the five spacers to prevent loss.

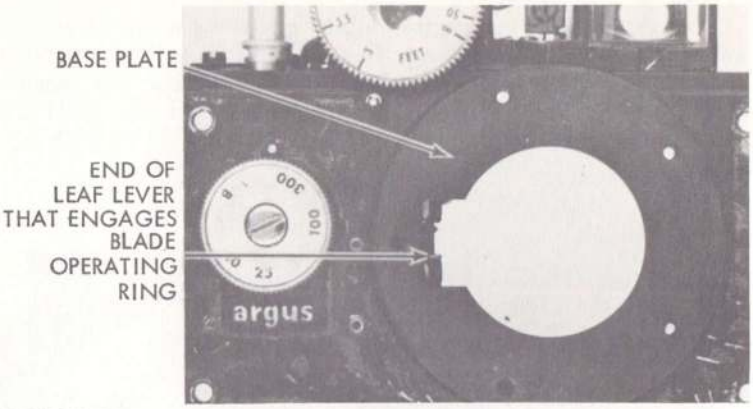


FIGURE 46

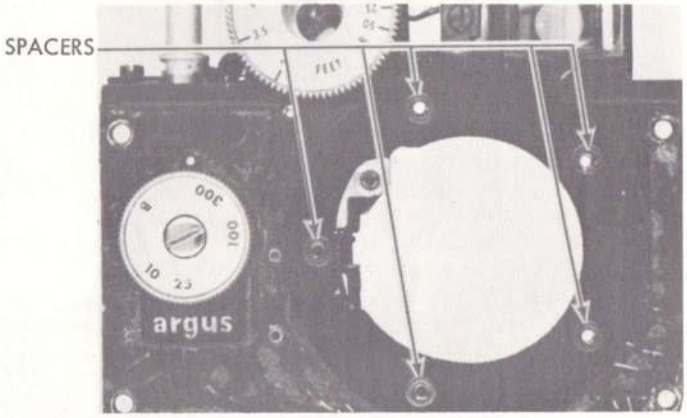


FIGURE 47

The leaf lever assembly is held by two screws (visible in figure 35). Insert your screwdriver through the hole in the camera body (also visible in figure 35) and remove the two screws and the leaf lever assembly. The holes in the leaf lever plate are elongated, permitting a sliding adjustment for the leaf lever -- we'll discuss this adjustment during reassembly.

There is also an adjustment on the vertical position of the main drive column. The main drive column is mounted on two threaded pivots -- one at either end. By turning one pivot out and the other in, you can change the vertical position of the main drive column. Of course, removing the main drive column disturbs the adjustment -- so for now, notice that the star wheel cam

on the main drive column is approximately centered on the sync pallet, Fig. 38.

NOTE: Removing the main drive column requires re-tensioning the mainspring on reassembly. The correct amount of initial tension must be applied to the main-spring to bring the 1/300 second shutter speed into time. Since your next lesson describes the methods of testing shutter speeds, we'll just go through the disassembly and tensioning procedures in this text.

To remove the main drive column, you should first let off the mainspring initial tension. The trick in letting off the initial tension is to release the shutter without cocking (and thereby tensioning) the mainspring. Since you aren't adding tension to the mainspring by cocking the shutter, each revolution of the main drive column lets off one turn of initial tension.

Using your screwdriver blade, push up on the released-position latch -- thereby disengaging the main drive column. The main drive column now moves from its released position to its "ready" position, held by the inner release lever. Next, release the shutter by depressing the release plunger. The main drive column then runs through its release cycle and lets off one turn of initial tension.

Repeat this procedure until the mainspring cannot turn the main drive column through its cycle -- that is, until there isn't enough tension left to turn the main drive column. Then, use your finger to turn the main drive column in the release direction and let off any remaining tension. You should now know how many turns of initial tension were originally on the spring.

To remove the main drive column, you must loosen the two threaded pivots. The upper pivot, on top of the mechanism, may be reached through the access hole in the rangefinder base plate, Fig. 48. But we'll remove the rangefinder assembly so you can more easily see the upper pivot and the other adjustments. The rangefinder assembly is one complete unit held to the shutter mechanism by two screws.

NOTE: The holes in the rangefinder base plate (for the two screws) are elongated, permitting a sliding adjustment for the rangefinder. If you remove the rangefinder, you may have to make the sliding adjustment on reassembly

(so the rangefinder disc properly engages the focusing ring). But to make things easier, you can simply scribe around the edge of the rangefinder base plate before removal. Then, on reassembly, position the rangefinder according to your scribe lines.

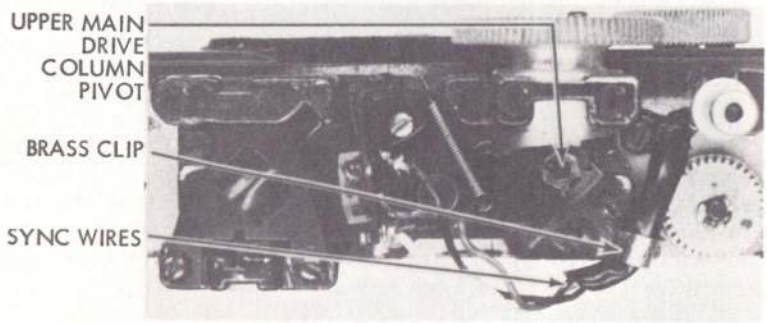


FIGURE 48

Bend back the brass clip holding the sync wires, Fig. 48, and move the sync wires away from the rangefinder assembly. Now, remove the two rangefinder retaining screws pointed out in figure 49 (notice that one of the screws also holds the brass clip for the sync wires). Finally, lift the complete rangefinder assembly up and off the camera body.

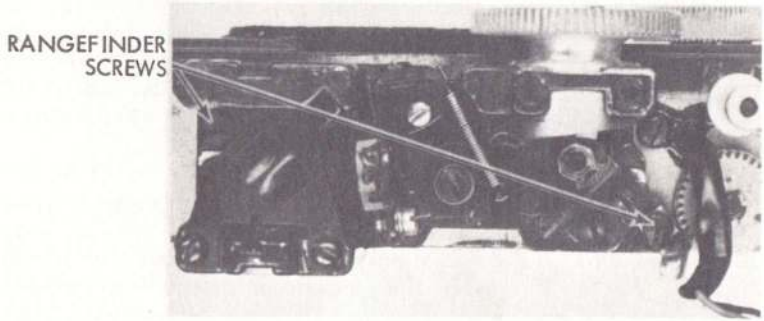


FIGURE 49

Before you loosen the pivots, try moving the main drive column up and down with your finger -- mentally note the amount of endplay you can feel. On reassembly, you'll want to adjust the pivots for this slight endplay in the main drive column.

The upper pivot for the main drive column is now clearly visible, Fig. 50. A hexagonal nut holds the threaded pivot in its

adjusted position. Loosen the hexagonal nut and turn the pivot about two turns in a counterclockwise direction -- the upper end of the main drive column is now free.

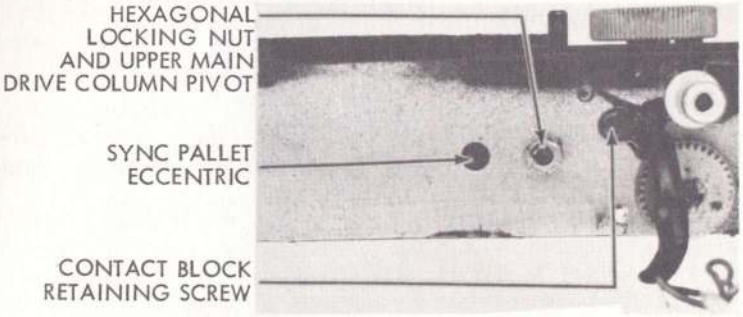


FIGURE 50

Next, locate the cover screw for the lower pivot at the bottom of the assembly, Fig. 51. Using a spline key of the proper size, take out the cover screw. There may be slugs under the cover screw -- if so, remove the slugs to reach the lower pivot.

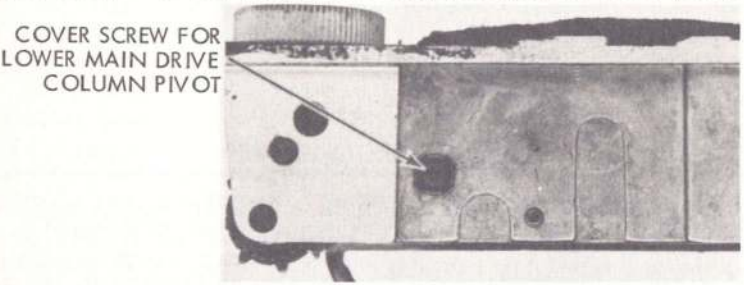


FIGURE 51 BOTTOM OF ASSEMBLY

Looking through the cover screw hole, locate the lower main drive column pivot -- this pivot has a left-hand thread. So turn the lower pivot in a clockwise direction until you can lift out the main drive column and the mainspring.

Figure 52, showing the main drive column, points out the name of each lug and cam. If you'll look into the cavity at either end of the main drive column, you should spot a ball bearing -- one ball bearing is spun into the base of the cavity at each end of the main drive column. The ball bearings, which engage the pivots, should not come out in normal disassembly -- but you should nonetheless check to make sure both ball bearings are present.

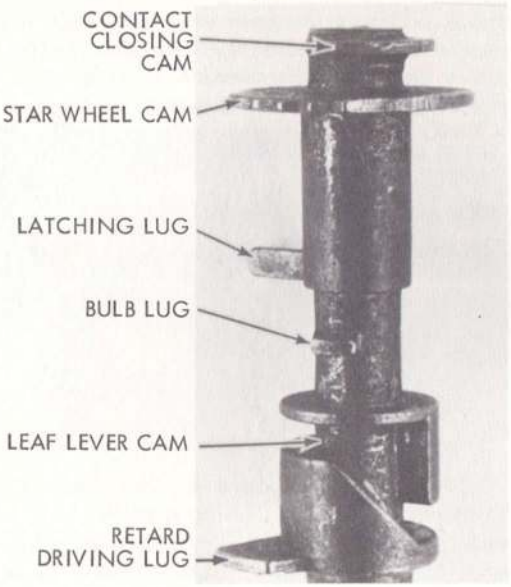


FIGURE 52 MAIN DRIVE COLUMN

REPLACING THE MAIN DRIVE COLUMN IN THE ARGUS C-4

The parts remaining in the shutter mechanism may be cleaned without further disassembly. After cleaning the main drive column, lubricate the two ball bearings with moly-lube. Now, place the mainspring in position on the wind cam (you can see the proper mainspring placement in figure 35).

Seat the upper end of the main drive column first -- then, swing the lower end into position. Make sure that the upper end of the mainspring hooks behind the retard driving lug on the main drive column.

The main drive column should now be in the released position -- that is, with its latching lug engaged by the released-position latch.

Next, turn down the two pivots to hold the main drive column. Adjust the pivots as previously described until the star wheel cam (on the main drive column) centers on the sync pallet. Remember to leave the slight endplay in the main drive column.

For now, we will put two turns of initial tension on the mainspring. If everything is working properly, two turns of tension should be sufficient to cock and release the shutter. But the initial tension may require further adjustment to bring in the shutter speeds.

Cocking the shutter adds initial tension to the mainspring. So we want to cock the shutter twice without releasing it -- the mainspring then retains the initial tension.

First, cock the shutter by turning the sprocket in the film-advance direction. Then, turn the main drive column slightly in a clockwise direction (as seen from the top of the mechanism) until it is latched by the released-position latch. Although the main drive column is now in its released position, the lower end of the transfer shaft still blocks the wind cam -- preventing you from cocking the shutter again. So just depress the release plunger -- that moves the transfer shaft below the lug on the wind cam. Now, cock the shutter a second time by turning the sprocket.

You have just applied two full turns of initial tension to the mainspring. Once again, turn the main drive column clockwise until it is held by the released-position latch and depress the release plunger. You can now cock and release the shutter in the normal manner.

Test the shutter operation at all of the shutter speeds. Then, set the speed knob to "bulb" -- cock and release the shutter, but hold the release plunger depressed. While the main drive column is held by the bulb lever, check the relationship between the bulb lug (on the main drive column) and the latching end of the bulb lever -- the bulb lever should be centered on the bulb lug. If the bulb lever does not catch the bulb lug properly, you may have to make another slight adjustment to the main drive column pivots.

REPLACING THE ARGUS C-4 SHUTTER BLADE ASSEMBLY

NOTE: We removed the leaf lever after taking out the shutter blade assembly. However, we'll reassemble the shutter blade assembly before replacing the leaf lever -- that way, we can test the operation of the blade operating ring for free movement.

Working from the front of the camera, replace the five spacers within the holes in the felt pad. Seat the black base plate with

its cutout positioned as shown in figure 46, and align the holes in the base plate with the screw holes in the front plate. Next, replace the brass plate, aligning its screw holes with the holes in the base plate. Seat the blade operating ring with its forked tab pointing down and passing through the cutout in the base plate.

Locate the five raised "dimples" on the shutter blade mounting ring -- these "dimples," which hold the shutter blades, must go up. Seat the shutter blade mounting ring and align its five holes.

Now, rotate the blade operating ring clockwise to the full-open position (it's much easier to replace the shutter blades in the open position). Place the first blade over the locating pins nearest the forked tab on the blade operating ring. Then, replace the next four blades in clockwise rotation.

Depending on the particular camera, you now have one or more blades left over. These extra blades act as spacer and cover blades. Place the sixth blade over the pins for the first blade, and place the seventh blade over the pins for the second blade -- that is, just start over with your clockwise rotation until you have installed all of the shutter blades. Then, position the five blade spacers over the screw holes.

You must be very careful while seating the second plate in position -- otherwise, you can disturb the positions of the shutter blades and the blade spacers. The larger holes in the second plate go over the blade pins, while the smaller holes align with the screw holes in the blade mounting ring.

Finally, seat the first plate and the lens mounting ring. Replace the five retaining screws to hold the shutter blade assembly in place.

To test the operation, turn over the shutter mechanism and locate the forked tab on the blade operating ring. Use your screwdriver blade to move the forked tab up and down -- opening and closing the shutter blades. The blade operating ring should move smoothly and freely.

REPLACING AND ADJUSTING THE LEAF LEVER IN THE ARGUS C-4

Before replacing the leaf lever, lightly lubricate the leaf

lever cam in the main drive column with moly-lube. Now, seat the leaf lever in place -- one end of the leaf lever hooks to the forked tab on the blade operating ring, while the other end fits within the leaf lever cam in the main drive column. Replace the two screws to hold the leaf lever in place.

You can now cock and release the shutter to test the operation. Remember, we mentioned that the leaf lever has a sliding adjustment -- by loosening the two screws, you can slide the entire leaf lever assembly up or down. If the leaf lever is sitting too low, the shutter blades won't be held fully open on "bulb"; and if the leaf lever is sitting too high, the blades may not close completely.

Set the speed knob to "bulb" and depress the release plunger -- hold the release plunger depressed to keep the blades open. If the blades aren't fully open, loosen the two screws holding the leaf lever. Now, still holding the blades open on "bulb," slide the leaf lever assembly up until the blades are fully open -- as they are in figure 37. And, after making the adjustment, make sure the leaf lever retaining screws are snugly tight.

ADJUSTING THE SHUTTER SPEEDS IN THE ARGUS C-4

There are two shutter speed adjustment points in the Argus C-4 -- one is the amount of initial tension on the mainspring; and the other is the position of the speed cam.

Remember, you can alter the amount of initial tension by full-turn increments. Check the shutter operation at 1/10 second, the slowest shutter speed -- if you have sufficient initial tension on the mainspring, the shutter should run through smoothly at 1/10 second.

But the fastest shutter speed -- 1/300 second -- is your indication of the precise amount of initial tension necessary. You'll soon learn the procedures for testing shutter speeds. For now, remember that you must add initial tension to make the 1/300 second faster, and let off initial tension to make the 1/300 second slower.

NOTE: If you have to add more than two turns of initial tension, you may note that the mainspring "buckles" slightly. A slight amount of buckle won't damage the mainspring. But if the buckle is excessive, there is probably some other reason that the shutter speed isn't coming up to 1/300 second. Rather than adding more initial tension, check thoroughly for a camera malfunction.

The initial test of the speed cam position is similar to that we described for the Argus C-3. You should have no retard on the fastest speed (1/300 second), and just a whisper of retard on the next-to-the-highest speed (1/100 second). But for critical accuracy, you can adjust the speed cam according to the procedures we'll describe in your next lesson.

The Argus C-4 speed cam has an in-and-out adjustment. So for less retard (and thereby a faster speed), we move the entire speed cam in -- toward the escapement. And for more retard (and thereby a slower speed), we move the speed cam toward the speed knob.

To reach the speed cam adjustment point, first take off the speed knob by removing its center screw -- there's a compression spring under the speed knob. Now, locate the brass speed control disc with its locking spline screw, Fig. 53. By loosening the locking screw, you can rotate the speed control disc and thereby change the amount of retard for the speeds of 1/100 second through 1/10 second.

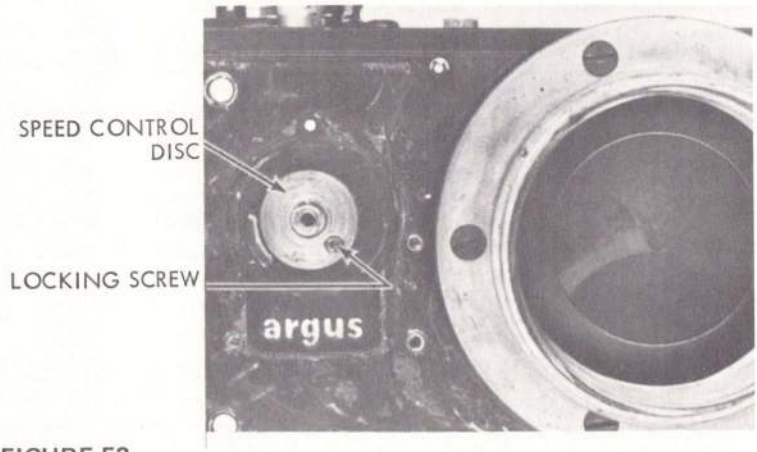


FIGURE 53

ADJUSTING THE SYNC DELAY IN THE ARGUS C-4

The methods of testing sync delay are also covered in future lessons. So for now, we'll just point out the specific adjustment points in the Argus C-4.

Remember, the "X" contacts should be held apart by the contact closing cam on the main drive column. And, when the

blades are fully open, the "X" contacts should close to fire the flash. By restraining the main drive column during its release rotation, you can visually check for the proper operation of the movable contact blade.

The adjustment for the opening and closing of the sync contacts is located on the top of the camera. The screw shown in figure 50 holds the contact block -- by loosening the screw, you can shift the contact block in position. Move the contact block either closer to or farther from the contact closing cam (on the main drive column) until the contacts open and close as previously described.

There is also an adjustment for the length of the "M" sync delay. To change the "M" sync delay, you can adjust the depth that the sync pallet engages the star wheel cam on the main drive column.

For example, say you've adjusted the contact block for proper operation of the movable contact blade -- "X" sync now tests correctly. But when checking "M" sync, you find that the delay is too long (the "M" sync delay should be between 17 and 19 milliseconds). In other words, you must decrease the depth of sync pallet engagement.

First, loosen the spline locking screw accessible through the hole above the sync pallet, Fig. 38. Loosening the locking screw allows you to turn the sync pallet eccentric, Fig. 50. And the sync pallet eccentric moves the sync pallet either closer to or farther from the star wheel cam.

COMPLETING THE ARGUS C-4 REASSEMBLY

Replace the rangefinder with its two screws. Hook the sync wires under the brass clip and press the clip over the wires, as shown in figure 48. Make sure that neither the wires nor the clip interfere with the upper wind gear, Fig. 48.

Now, seat the front plate/shutter assembly in the camera body and replace the four retaining screws. Set the rangefinder disc to infinity and replace the lens focusing ring with its retaining ring -- remember, the last tooth on the focusing ring should engage the rangefinder disc at infinity.

Since you disturbed the lens focus by removing the lens, you must readjust the lens for infinity during installation. That is, if

you attach a ground glass to the focal plane, you can screw in the lens until an infinity target viewed on the ground glass is in sharp focus.

First, loosen the three spline screws around the knurled lens adjusting ring, Fig. 28. Now, while watching the ground glass image of an infinity target, screw in the lens until the image is at its sharpest focus. Without changing the lens position, rotate the lens adjusting ring until the hole for the lens pin screw, Fig. 28, aligns with the slot in the focusing ring. Then, replace the lens pin screw and tighten the three spline screws around the lens adjusting ring.

The remaining reassembly procedure just involves reversing the order of your disassembly.